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February 3, 1998

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
1919 M. St., NW, Room 222
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

RE: Ex Parte Presentation – Proxy Cost Models
CC Docket No. 96-45

Dear Ms. Salas:

The attached document is the complete set of revised documentation for the HAI Model, Release 5.0a. It is being provided to the Commission to assist in its evaluation of the HAI Model for use in establishing universal service costs. Also included is a separate set of sheets that list the significant changes that have occurred in the model between Releases 5.0 and 5.0a.

Two copies of this Notice are being submitted to the Secretary of the FCC in accordance with Section 1.1206(a)(2) of the Commission's rules.

Sincerely,

Richard N. Clarke / ha

Richard N. Clarke

Attachments

cc: Chuck Keller
Robert Loube
Natalie Wales
Brad Wimmer
Sheryl Todd

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Changes Incorporated in HM 5.0a from HM 5.0

Distribution Module

- HM 5.0a modifies its method of dividing clusters to more efficiently ensure that the length of cables carrying analog signals never exceeds the user-set maximum (default = 18,000 ft). It does this by modifying the method used to calculate the backbone and branch cable divisors that are used to ensure that the length of cables carrying analog signals never exceeds the user-set maximum. The divisors now include a term containing the aspect ratio of the cluster area. This permits a more accurate division of the backbone and branch cables to maintain the total distance within the user-set maximum. The corresponding calculations in HM 5.0, while not incorrect, would occasionally divide branch or backbone cables unnecessarily because they did not consider the effect of the cluster aspect ratio on relative cable lengths. The changes appear in the "calculations" worksheet, columns S and U for, respectively, backbone and branch cable lengths.

- HM 5.0a corrects minor typographical errors in equations CV and DA of the "calculations" sheet that help to calculate the portions of structure that "swing" between buried and aerial based on abnormal local life-cycle costs; and an additional typographical error in column DZ dealing with the wireless cap equations.

Switching and Interoffice Module

- The distance formulas in the "wire center investment" worksheet, columns BL and CE, obtain the distances calculated by the VBA code directly from the "ring io" worksheet that serves as a scratchpad area for the VBA calculations, and the ring capacity calculation, Column CF of the "wire center investment" worksheet, similarly obtains the ring DS3 count from the "ring io" worksheet. This reduces the execution time for large companies compared to HM 5.0, in which the ring VBA code wrote the computed distances into the "distance inputs" worksheet, a time-consuming procedure that led to very long execution times for companies with many wire centers located on rings.

- For wire centers owned by LECs without local tandems, the equivalent investments in facilities and terminal equipment associated with the leased circuits connecting the BOC wire center to its tandem are calculated on a per-DS0 basis, consistent with the provision of those circuits on BOC rings. This is in contrast to the previous method of using an amount per mile multiplied by the number of miles between the wire center and tandem. The default values for the equivalent facilities and terminal investments, $138.08 and $111.62 per DS0, respectively, are based on the average investments for 32 large LECs.[1] Also, the "equivalent distance" calculation ("wire center investment" worksheet, column

[1] If the users wishes to use an input values that is specific to the BOC transport network serving the small company, this figure can be extracted from the BOC's computed investments as reported in a run of the BOC's Density Zone Expense Module, "cost detail" worksheet, cells B68 and B69.

CG) is no longer used, as its function is replaced by the equivalent facilities and terminal investments discussed above.

- Nonhost-remote rings now must have a minimum of four nodes, assuming there are that many wire centers, versus a prior minimum of two nodes. In addition, the default minimum wire center lines threshold for placement on a ring has been reduced from 5000 lines to 1 line.

- HM 5.0a provides several new "traps" to prevent certain execution problems. These include: 1) the ring-generating code is modified to expect the user-specified "host/remote enable" option as boolean type rather than a string; 2) stand-alone tandems now have an associated interoffice distance; 3) the number of allowed wire center records has been increased from 1,500 to 2,000; 4) the ring-generating code contains logic to determine whether host/remote calculations are enabled before eliminating remotes as first order ring candidates; 5) the ring-generating code uses wire center records generated from the HM5.0a database as the source of the locations associated with a particular state and operating company; 6) the ring-generating code now updates the progress bar in closer proportion to the module's degree of completion; 7) the ring-generating code writes all results into a list in the "ring io" worksheet; 8) the array dimension in the routine computing interoffice mesh distances has been increased from 25 to 100 elements; and 9) several additional "divide checks" are provided and syntax errors corrected. These include adjustment to the BHCA trigger for placing a second switch in a wire center and the sharing of structure cost between feeder and interoffice transport.

Expense Modules

Density Zone and Wire Center Versions

- Corrects the calculation of weighted average depreciation life for non-metallic cable to include interoffice fiber facilities ("Inputs" worksheet, at cells L28, L30, and L32), eliminating a situation in which HM 5.0 could produce "divide by zero" errors for very small companies with no fiber feeder plant.

- The "Cost detail" sheet of the DZ version allows for the substitution of ICO-equivalent DS0 transport values.

- Corrects cell references for residential and business usage in the wire center USF sheet from absolute to relative.

Expense Modules – CBG and Cluster Versions

- Improves on the previous CBG expense module by associating cluster costs to the several CBGs that may overlay the cluster in proportion to the relative number of lines that each CBG displaces of the cluster's total quantity of lines.

- Adds a Cluster expense module that displays cost results on a customer cluster-by-cluster basis.

Interface Items

- Corrects several non-functioning items in the interface, including: 1) permitting Puerto Rico to be run through the interface; 2) fixing the OLE error that previously has occurred the initial time the newly installed HM 5.0 is run; and 3) speeding the run time of the Feeder module

Input Data Items

- Corrects several data discrepancies, including: 1) correcting the several "problem clusters" that previously were incorrectly sized; 2) adding the clusters that were missing from the California data; and 3) assigning correctly the lines density classification of Puerto Rico clusters; and 4) correcting the state assignment of several small LECs that operate across state borders.

- Adds CBGMulti data table that relates clusters to the several CBGs that overlay them based on relative counts of lines associated with each CBG.

HAI Model

Release 5.0a

Model Description

HAI Consulting, Inc.

737 29th Street, Suite 200
Boulder, Colorado 80303

February 2, 1998

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1. Introduction

1.1. Overview

The HAI Model, Release 5.0a ("HM 5.0a") has been developed by HAI Consulting, Inc. ("HAI"), of Boulder, Colorado,[1] at the request of AT&T and MCI for the purpose of estimating the forward-looking economic costs of:

a) Basic local telephone service;

b) Unbundled network elements ("UNEs"); and

c) Carrier access to, and interconnection with, the local exchange network.

All three sets of costs are calculated based on Total Service Long Run Incremental Cost ("TSLRIC") principles, and use a consistent set of assumptions, procedures and input data.[2]

The HAI Model uses the definition of basic local telephone service adopted by the Federal-State Joint Board on Universal Service ("Joint Board") for universal service funding purposes. The Joint Board states that the following functional elements are to be considered as required components of universal service:[3]

- single-line, single-party access to the first point of switching in a local exchange network;
- usage within a local exchange area, including access to interexchange service;
- touch tone capability;
- access to 911 services, operator services, directory assistance, and telecommunications relay service for the hearing-impaired.

Excluded from this definition of universal service are many other local exchange company ("LEC") services, such as toll calling, custom calling and CLASS[SM] features,

[1] With its Release 5.0a, the model formerly known as the Hatfield Model is now named the HAI Model. Hatfield Associates, Inc., the firm that developed prior versions of the Hatfield/HAI Model no longer performs telecommunications consulting. All of the staff of Hatfield Associates who have played an active role in developing the Hatfield/HAI Model have formed a successor firm, called HAI Consulting, Inc.

[2] When applied to the costing of unbundled network elements, TSLRIC equates to Total Element Long Run Incremental Costs, or TELRIC as the term is used by the Federal Communications Commission.

[3] Federal-State Joint Board on Universal Service, CC Docket No. 96-45, Recommended Decision, November 8, 1996, ("Recommended Decision") Paragraph 45-53, 65-70.

private line services and white pages directory listings.[4] The existence of such services is taken into account in developing the cost estimates for UNEs -- to the extent that the joint provision of UNEs and other services impacts the costs of UNEs. Model users also may adjust the degree to which several specific UNEs are included in calculating universal service support requirements.

The HAI Model calculates the costs of the following UNEs:

- Network Interface Device ("NID")
- Loop Distribution
- Loop Concentrator/Multiplexer
- Loop Feeder
- End Office Switching
- Common Transport
- Dedicated Transport
- Direct Transport
- Tandem Switching
- Signaling Links
- Signal Transfer Point ("STP")
- Service Control Point ("SCP")
- Operator Systems
- Public Telephones

Finally, the model estimates the per-minute economic cost of providing local network interconnection and access. These are estimated for connection points at end office and tandem switches.

The model constructs a "bottom up" estimate of the pertinent costs based upon detailed data describing demand quantities, network component prices, operational costs, network operations costs, and other factors affecting the costs of providing local service. The model's demand data, particularly data describing customer locations, line demand, and traffic volumes, serve as the key initial drivers. From these data, the model engineers and costs a local exchange network with sufficient capacity to meet total demand, and to maintain a high level of service quality.[5] The model's inputs also include the prices of various network components, with their associated installation and placement costs, along with various capital cost parameters. These data are used to populate detailed input tables describing, for example, the cost per foot of various sizes of copper and fiber cable, cost per line of switching, cost of debt, and depreciation lives for each specific network component.

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[4] Although previous versions of the Hatfield/HAI Model included the monthly cost of maintaining a white pages telephone listing for each subscriber, the Joint Board and FCC have explicitly excluded this item from the definition of supported universal service. Thus, in HM 5.0a its inclusion in cost calculations for basic service is only at the user's express direction.

[5] In general, the level of service quality engineered into the HAI Model exceeds, by a substantial margin, the customary level of basic service quality offered by the LECs over their embedded networks.

Using these data, the model calculates required network investments by detailed plant category. Next, the capital carrying cost of these investments is calculated. Operations expenses are then added to compute the total monthly cost of universal service, various unbundled network elements, stated on both a total cost and an appropriate per-unit basis, and carrier access to and interconnection with the local exchange network. Costs can then be displayed on a study area, density zone,[6] wire center, Census Block Group ("CBG"), or customer cluster basis.[7]

This document describes the structure and operation of the HM 5.0a, including a discussion of various inputs to the model. Section 1.2 describes the recent evolution of the Hatfield/HAI Model. Section 2 summarizes changes made to the model between HM 4.0 and this version. Section 3 provides a general overview of the local network being modeled. Section 4 reviews briefly the structure of the model and its data. Section 5 focuses on the method by which customer locations are determined and clustered. Section 6 describes in detail each module and its operation. Section 7 summarizes the document.

Appendix A provides a brief history of the Hatfield/HAI Model. Appendix B identifies the user inputs to the model and their default values. Appendix C provides flow charts describing the data input development process used to obtain demographic and geological information, residence and business line counts, wire center mappings and loop distances. Appendix D describes the HM 5.0a's calculation of interoffice network distances. Finally, Appendix E provides equation listings of the HM 5.0a's network engineering logic modules.

1.2. Evolution of the Hatfield/HAI Model

On May 7, 1997, the FCC released its Order implementing the mandate for universal service contained in the Telecommunications Act of 1996. In the Order, it declined, on the basis of its current record, including the Report of the State Members of the Joint Board, to endorse a model, and indicated it would issue a Further Notice of Proposed Rulemaking (FNPRM) detailing what it believed to be the appropriate requirements and guidelines that such a cost methodology should incorporate. This FNPRM was released on July 18, 1997. In this FNPRM the FCC provided a wealth of information about what the Commission believes are the appropriate properties to be incorporated into a proxy cost methodology. These include:

- A more sophisticated and precise method of locating customers;

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[6] The HM 5.0a differentiates among density zones based on the number of subscriber access lines per square mile of service area.

[7] A CBG is a unit defined by the U.S. Bureau of the Census, and nominally comprises between 400 and 600 households. Customer clusters are dynamically formed aggregations ranging from singleton isolated customer locations, up to 1800 customer locations. See, Section 5.5 below, for a description of the spatial and size criteria used by the HM 5.0a in forming customer clusters.

- A choice of outside plant technologies and structures that reflects more closely local cost conditions;

- Explicit modeling of host/remote relationships between end office switches; and

- More flexible assignments of expenses based either on lines or relative investments.

The Commission set up a series of weekly meetings, and Comment and Reply cycles to address each of these and other related issues in greater depth. The Commission also indicated its intention to select a model for determining universal service support for nonrural carriers by the end of 1997.

HM 5.0a, as here submitted, is responsive to each the Commission's requirements as presented in the Order, the requirements outlined in the FNPRM on cost modeling, and the public notice guidance provided by the Commission subsequent to its release of the FNPRM. Indeed, HM 5.0a represents a revolutionary advance in the modeling of local telephone network costs by its incorporation of:

- Actual gecoded customer locations;

- An algorithm that identifies clusters of customers that may be served efficiently together – without recourse to arbitrary geographic limitations;

- Numerous optimization routines that ensure the use of outside plant that is most technically and economically suited to particular local conditions;

- Explicit specification of host, remote and stand-alone switches;

- An optimizing algorithm for the creation of efficient interoffice SONET transport rings; and

- Opportunities to allocate flexibly expenses based on lines or relative investments.

As a result of these many changes, HM 5.0a has refined greatly the task of identifying actual customer locations, and clustering them into units logically served by telecommunications outside plant. The model has thus moved well ahead of other models that employ more geographically limited, rule-of-thumb calculation techniques.

HM 5.0 was originally submitted to the FCC on December 11, 1997. A number of small but significant changes have been made to the Model's data, logic and documentation since that time. These are incorporated into a revision referred to as HM 5.0a, released January 28, 1998. Section 2.8 summarizes the changes between HM 5.0 and HM 5.0a. To the extent those changes impact the model description, they are reflected in this document.

2. Summary of Changes Between HM 4.0 and HM 5.0

The changes between HM 5.0 and the previous release of the model, HM 4.0, are summarized in the first portions of this section. Section 2.8 summarizes the changes between HM 5.0 and HM 5.0a. All of these changes are reflected in the discussion of how HM 5.0a operates, presented in Sections 4 and 6.

2.1. User Interface

- The new features of the user interface provide the user with many additional inputs and options. Among the new inputs included are the ability to designate specific end office switches as hosts, remotes, or standalones – as well as to assign remotes to a particular host; ability to specify variable T1 repeater spacing; ability to enable the steering of feeder toward population clusters within a quadrant; the ability to invoke a wireless distribution option if its cost is less than wireline, and many more.

- The interface also now allows the user to select multiple companies from one or more states (limited only by hard drive space) to be run in automatic sequence by the model. Expense Modules and workfiles are then produced for each individual company, and their universal service calculations rolled up.

2.2. Input Data

- The HM 5.0a input data locate customers much more precisely. These data determine the actual precise locations of as many customers as possible through latitude and longitude geocoding of their addresses. The remainder are located to at least the Census Block ("CB") level of precision and are assumed to be placed along the CB's periphery.[8]

- A clustering algorithm is used to determine groupings of customers that have extremely realistic correlation to efficient distribution areas.

- The August 1997 Local Exchange Routing Guide ("LERG") is used to identify and locate LEC wire centers.

- Business Location Research ("BLR") wire center boundaries are used to associate customer locations with LEC wire centers. This ensures that all identified clusters

[8] Previous versions of the HM only located customers precisely to their Census Block Group (CBG). Within high density CBGs, customers were assumed either to be spread uniformly across the CBG. In low density CBGs, a portion of customers was assumed to be clustered in quadrants, while another portion was assumed to spread along outlying roads.

are restricted to include only customer locations that fall within the boundaries of a single wire center.

- Company line count totals are determined from the most recent available data, including that provided in the 1996 ARMIS data and NECA USF Loops filing for 1996.
- The method of estimating line counts by LEC wire center is refined, and line counts can be determined by CB.
- 1996 ARMIS data (rather than 1995 ARMIS data) are used to estimate traffic volumes and expense inputs.

2.3. Outside Plant Selection

- HM 5.0a automatically adjusts buried and aerial structure fractions to account for varying maintenance costs and placement costs occasioned by local soil conditions and bedrock. The amount of one type of structure substituted for another depends both on differences in placement costs and on a life-cycle analysis of maintenance and capital carrying costs of the two types of structure.

2.4. Distribution Module

- HM 5.0a lays its distribution plant directly over the actual identified locations of customer clusters.
- Rather than assuming that the distribution area is square, HM 5.0a engineers its distribution grid as a rectangle. The aspect ratio (height-to-width) of this rectangle is determined by the data input development process for each cluster, and distribution cable is laid out in a fashion that reflects this aspect ratio.
- HM 5.0a serves "outlier" clusters from "main clusters" on which they home, using digital T1 technology whenever the road cable length exceeds a user-adjustable maximum analog copper distance.[9] The cables carrying T1 signals to the outlier clusters are separate from the analog copper cables that extend from the T1 terminal in each outlier cluster to the customer locations within the outlier cluster.
- Assuming that the distance of a cable run is sufficiently short so that use of copper feeder is a technically acceptable option, the HM 5.0a performs an analysis of the relative life-cycle costs of copper versus fiber feeder to determine which feeder technology should be used to serve the given main cluster.

[9] Outlier clusters are clusters that contain fewer than five lines. Main clusters are cluster containing five or more lines. These clusters are served by feeder linking them to their serving wire center. See Section 6.3.2 for more detail.

- The HM 5.0a also incorporates an optional, user-adjustable "cap" on distribution investment. This cap is structured to reflect the potential cost structure of wireless distribution technologies.

2.5. Feeder Module

- HM 5.0a engineers feeder to serve actual population main clusters (and uses distribution cable to serve main clusters' subtending outlier clusters), rather than simply engineering to each CBG.

- At the user's option, the HM 5.0a "steers" feeder routes toward the preponderant location of main clusters within a given wire center quadrant.[10] When this steering is invoked, the user may also apply an adjustable route-to-airline distance multiplier to the amounts of cable placed along these "steered" feeder routes.

- Manhole placement costs are increased by a user-specified amount whenever the local water table depth is less than the user-specified threshold.

2.6. Switching and Interoffice Module

- At the user's discretion, HM 5.0a will both engineer and cost explicit combinations of host, remote and stand-alone end office switches. If the user does not make such a specification, the HM 5.0a defaults to computing end office switching investments using input values that provide average per-line investments for an efficient portfolio of host, remote, and stand-alone switches.[11] If the host/remote/standalone designation option is invoked, the user is required to specify whether a wire center houses switches that are hosts or remotes, as well as to assign the correspondence between host and remote switches.

- Further, when the user chooses the model to distinguish explicitly between switch types, the HM 5.0a assumes that each host and its remotes are on a Synchronous Optical Network ("SONET") fiber optics ring separate from the interoffice rings used to interconnect host, standalone and tandem switches with each other.

- The HM 5.0a calculates explicitly a set of interoffice SONET rings that interconnect host, standalone, and tandem switches with each other. Based on this explicit specification of what wire centers are on each interoffice ring, the HM 5.0a determines associated ring distances using the actual locations of the wire centers along the ring. In addition, the rings are appropriately interconnected

[10] The default treatment, if steering is not invoked, is for the Feeder Module to calculate feeder distances using "right angle routing" in the four cardinal compass point directions, as employed in HM 4.0.

[11] The Model defaults to an average per-line mix because accurate data on the purchase prices of a portfolio of host, remote and standalone switches of varying capacities, and on the identification of hosts, remotes, and stand-alone switches, may not be available to the user.

with each other, and tandem switches are also interconnected if they fall within the same LATA.[12].

- The HM 5.0a engineers redundant paths and associated transmission terminal equipment for the point-to-point (folded) rings that may be specified to connect small offices to the larger wire centers on which they home.[13]

2.7. Expense Modules

- A Uniform System of Accounts ("USOA") detail worksheet is included that breaks out HM 5.0a investments and expenses by Part 32 account for comparison purposes.
- The proportion of total expenses that are assigned to loop network elements (i.e., NID, distribution, concentration and feeder) can be varied based either on relative number of lines, or on the relative amount of direct expenses (direct expenses include both maintenance expenses and capital carrying costs for the specific network elements).
- Both federal and state universal service fund requirements can be calculated in the density zone USF worksheet. This separate calculation permits differing state and federal cost benchmarks to be specified, as well as different collections of local services (e.g., primary and secondary residential lines, single business lines, etc.) to receive universal service support.
- In addition to displays of costs at the lines density zone and wire centers levels of aggregation, costs can also be displayed at the CBG and individual population cluster level.

2.8. Changes Incorporated in HM 5.0a

2.8.1. Distribution Module

- HM 5.0a modifies its method of dividing clusters to more efficiently ensure that the length of cables carrying analog signals never exceeds the user-set maximum (default = 18,000 ft).

[12] InterLATA links are excluded from the model because such links are not part of the local exchange network.

[13] The user may specify a minimum number of lines that a wire center must serve (default of just one) before that wire center is placed on an interoffice ring with other end office switches – rather than being interconnected directly only to its "home" wire center.

- HM 5.0a corrects minor typographical errors in equations used to calculate the portions of structure that "swing" between buried and aerial based on abnormal local life-cycle costs, and in the wireless cap equations.

- Adds columns that calculate average loop lengths.

2.8.2. Switching and Interoffice Module

- The time required to execute this module for large companies is reduced by sourcing from other portions of the workbook, rather than calculating, certain distance and DS3 count information.

- For wire centers owned by small LECs without local tandems, connectivity to a tandem is established in two pieces. First, a spur is engineered to the closest large LEC wire center that is on an interoffice ring. Second, the equivalent investments in facilities and terminal equipment associated with the required number of leased circuits on this ring that are used to connect this large LEC wire center to its tandem are calculated on a per-DS0 facilities basis. This is in contrast to the previous method of determining the cost of interoffice route between the Large LEC wire center and its tandem based on multiplying the distance between these nodes by an assumed dedicated circuit-mile charge.

- Rings now must have a minimum of four nodes, assuming there are that many wire centers, versus a prior minimum of two nodes.

- HM 5.0a provides several new "traps" to prevent certain execution problems. These include: 1) the ring-generating code is modified to expect the user-specified "host/remote enable" option as boolean type rather than a string; 2) stand-alone tandems now have an associated interoffice distance; 3) the number of allowed wire center records has been increased from 1,500 to 2,000; 4) the ring-generating code contains logic to determine whether host/remote calculations are enabled before eliminating remotes as first order ring candidates; 5) the ring-generating code uses wire center records generated from the HM5.0a database as the source of the locations associated with a particular state and operating company; 6) the ring-generating code now updates the progress bar in closer proportion to the module's degree of completion; 7) the ring-generating code writes all results into a list in the "ring io" worksheet; 8) the array dimension in the routine computing interoffice mesh distances has been increased from 25 to 100 elements; and 9) several additional "divide checks" are provided and syntax errors corrected.

2.8.3. Expense Modules

2.8.3.1. Density Zone and Wire Center Versions

- Corrects the calculation of weighted average depreciation life for non-metallic cable to include interoffice fiber facilities.

- The " Cost detail" sheet of the DZ version allows for the substitution of ICO-equivalent DS0 transport values.

- Corrects cell references for residential and business usage in the wire center USF sheet from absolute to relative.

2.8.3.2. Expense Modules – CBG and Cluster Versions

- Improves on the previous CBG expense module by associating cluster costs to the several CBGs that may overlay the cluster in proportion to the relative number of lines that each CBG displaces of the cluster's total quantity of lines.

- Adds a Cluster expense module that displays cost results on a customer cluster-by-cluster basis.

2.8.4. Interface Items

- Corrects several non-functioning items in the interface, including: 1) permitting Puerto Rico to be run through the interface; 2) fixing the OLE error that previously has occurred the initial time the newly installed HM 5.0 is run; and 3) speeding the run time of the Feeder module

2.8.5. Input Data Items

- Corrects several data discrepancies, including: 1) correcting the several " problem clusters" that previously were incorrectly sized; 2) adding the clusters that were missing from the California data; and 3) assigning correctly the lines density classification of Puerto Rico clusters; and 4) correcting the state assignment of several small LECs that operate across state borders.

- Adds CBGMulti data table that relates clusters to the several CBGs that overlay them based on relative counts of lines associated with each CBG.

- Adds data that permit easy calculation of average loop lengths by cluster and wire center.

3. Fundamental Structure of Local Network

3.1. Components of the Local Exchange Network

This section describes the network configuration and components modeled in HM 5.0a. Figures 1, 2 and 3 depict the relationships among the loop, switching, interoffice, and signaling network components.

3.1.1. Loop Description

Figure 1 depicts the loop model utilized in HM 5.0a. Section 3.1.1.1 defines the serving area. Section 3.1.1.2 provides a general description of the loop, depicted in Figure 1. Section 3.1.1.3 describes the loop components in more detail.

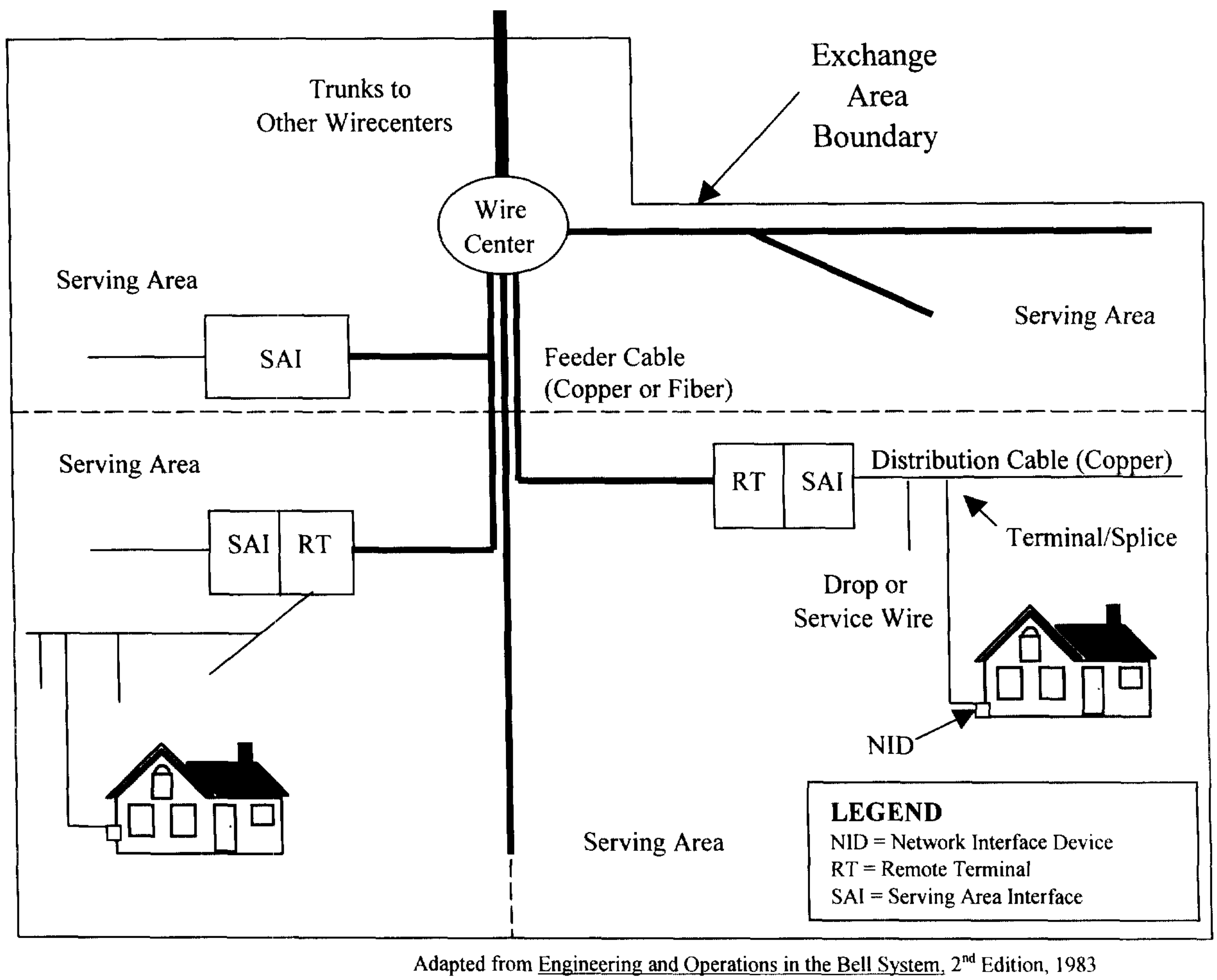

Figure 1 Loop Components

3.1.1.1. Serving Area

The total area served by a wire center is organized into one or more serving areas, each of which contains a portion of the area and lines served by the wire center. The serving areas are delineated by dotted lines in the above figure. In HM 5.0a the serving areas equate to main customer clusters and their subtending outlier clusters, as discussed in Section 6.2.

3.1.1.2. General Loop Description

One end of the feeder portion of the loop terminates within the central office building, or "wire center." Copper cable feeder facilities terminate on the "vertical side" of the main distributing frame ("MDF") in the wire center, and fiber optic feeder cable serving integrated digital loop carrier ("IDLC") systems terminates on a fiber distribution frame in the wire center.

The other end of the feeder extends to an appropriate termination point in the serving area. Copper feeder cables terminate on one or more serving area interfaces ("SAIs") in each serving area, where they are cross-connected to copper distribution cables. Fiber feeder cables extend to a digital loop carrier ("DLC") remote terminal ("RT") in the serving area, where optical digital signals are demultiplexed and converted to analog signals. Individual circuits from the DLC are cross-connected to copper distribution cables at an adjacent SAI.

Copper distribution cable extends from the SAI along routes passing individual customer premises. At appropriate points, these cables pass through block terminals typically serving several housing units. In the terminal, individual copper pairs in the distribution cable are spliced to "drops" that extend from the terminal to the customers premises. The drop terminates at a network interface device, or NID, at the customer's premises.

Feeder, distribution, and drop cables are supported by "structures." These structures may be underground conduit, poles, or trenches for buried cable and underground conduit. Underground cable is distinguished from buried cable in that underground cable is placed in conduit, while buried cable comes into direct contact with soil.[14] In more urban areas, aerial distribution cable may be attached directly to the outside of buildings, in what is called a "block cable" arrangement, or, for high-rise buildings, may consist of riser cable inside the building.

3.1.1.3. Local Loop Components

1) *Network Interface Device*

   The NID is the demarcation point between the local carrier's network and the customer's inside wiring. This device terminates the drop wire and is an access point that may be used to isolate trouble between the carrier's network and the customer's premises wiring. The NID also contains protection against externally-

[14] Although the conduit supporting underground cable is always placed in a trench, buried cable may either be placed in a trench or be directly plowed into the earth.

induced hazardous voltages, such as those associated with lightning strikes and contact between telephone and electric lines. In a multi-tenant building, the protection is located at the point at which the distribution cable enters the building.

2) *Drop*

A copper drop cable, typically containing several wire pairs, extends from the NID at the customer's premises to the block terminal at the distribution cable that runs along the street or the lot line. The drop can be aerial or buried; generally it is aerial if the distribution cable is aerial, and buried if the distribution cable is buried or underground.

3) *Block Terminal*

The "block terminal" is the interface between the drop and the distribution cable. When aerial distribution cable is used, the block terminal is attached to a pole in the subscriber's front yard at the edge of a road. A pedestal contains the block terminal when distribution cable is buried.

4) *Distribution Cable*

Distribution cable runs between the block terminals and an SAI located in the serving area. Limitations on the capacity of an SAI and/or the distribution design used in a particular serving area may lead to multiple SAIs. Distribution structure components may consist of poles, trenches and conduit.[15]

5) *Conduit and Feeder Facilities*

Feeder facilities constitute the transmission system between the SAI and the wire center. These facilities may consist of either pairs of copper wire or a DLC system that uses optical fiber cables as the transmission medium. In a DLC system, the analog signals for multiple individual lines are converted to a digital format and multiplexed into a composite digital bit stream for transmission over the feeder facilities

Feeder structure components include poles, trenches and conduit. Manholes for copper feeder or pullboxes for fiber feeder are also normally installed in conjunction with underground feeder cable. Manhole spacing is a function of population density and the type of feeder cable used. Pullboxes that are installed for underground fiber cable are normally farther apart than manholes used with

[15] Because underground distribution exists only in the highest density zones where runs are relatively short, and because in such zones underground structure is commonly shared with feeder, distribution facilities typically do not include manholes.

copper cables, because the lightness and flexibility of fiber cable permits it to be pulled over longer distances than copper cable.

Several utilities, e.g., electric utilities, LECs, IXCs and cable television ("CATV") operators, typically share structure because it is economical to do so. Manholes may be shared with low-voltage facilities. The amount of sharing of structure and manholes may differ in different density zones and between feeder and distribution cables.

3.1.2. Switching and Interoffice Network Description

This section provides a general description of the network components comprising the wire center and interoffice facilities. Figures 2 and 3 illustrate the relationships among the components described below.

3.1.2.1. Wire Centers

The wire center is a location from which feeder routes extend towards customer premises and from which interoffice circuits or "trunks" emanate toward other wire centers. A wire center normally contains at least one end office ("EO") switch and may also contain a tandem switch, an STP, an operator tandem, or some combination of these facilities. Wire center physical facilities include a building, power and air conditioning systems, rooms housing different switches, transmission equipment, distributing frames and entrance vaults for interoffice and loop feeder cables.

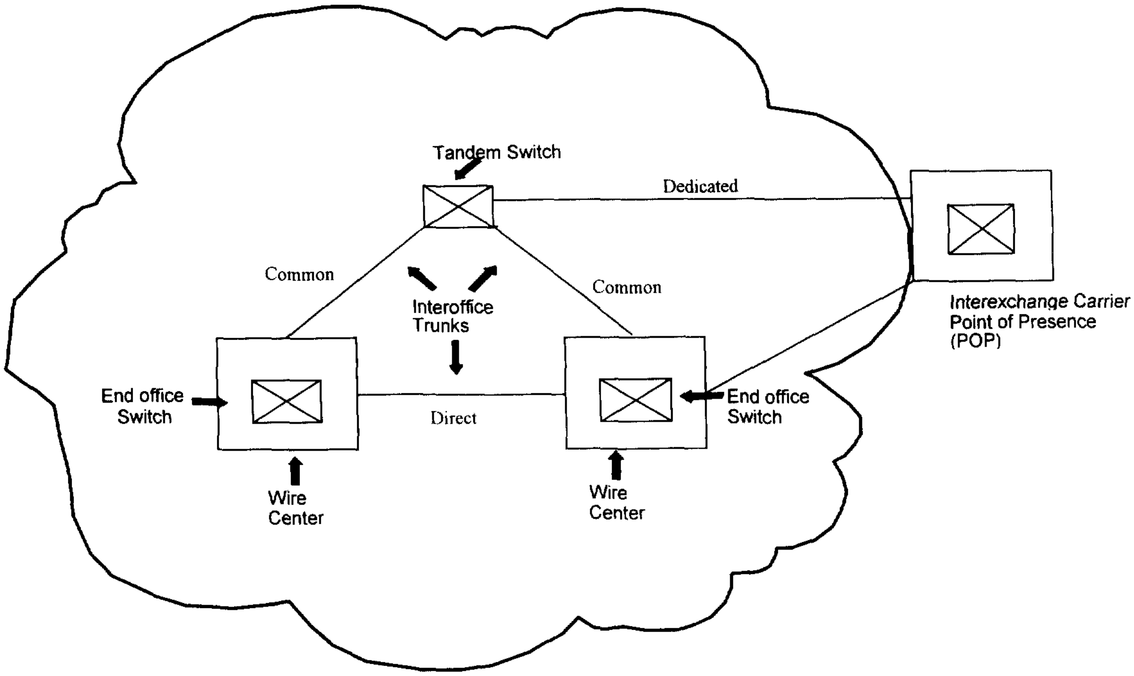

Figure 2 Interoffice Network

3.1.2.2. End Office Switches

The end office switch provides dial tone to the switched access lines it serves. It also provides on-demand connections to other end offices via direct trunks, to tandem switches via common trunks, to interexchange carrier ("IXC") points of presence ("POPs") via dedicated trunks, and to operator tandems via operator trunks.

3.1.2.3. Tandem Switches

Tandem switches interconnect end office switches via common trunks, and may also provide connections to IXC POPs via dedicated trunks. Common trunks also provide alternatives to direct routes for traffic between end offices. Tandem switching functions often are performed by switches that also perform end office functions. Tandems normally are located in wire centers that also house end office switches